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Gore

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[54] **PULSED ULTRA SONIC SWIMMING POOL ALARM APPARATUS**

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[51] **Int. Cl.**[5] **G08B 13/18**; G08B 21/00

[52] **U.S. Cl.** **340/573**; 340/531; 340/541; 340/572; 367/131; 367/137; 441/80

[58] **Field of Search** 340/573, 572, 531, 541; 367/131, 137; 441/80

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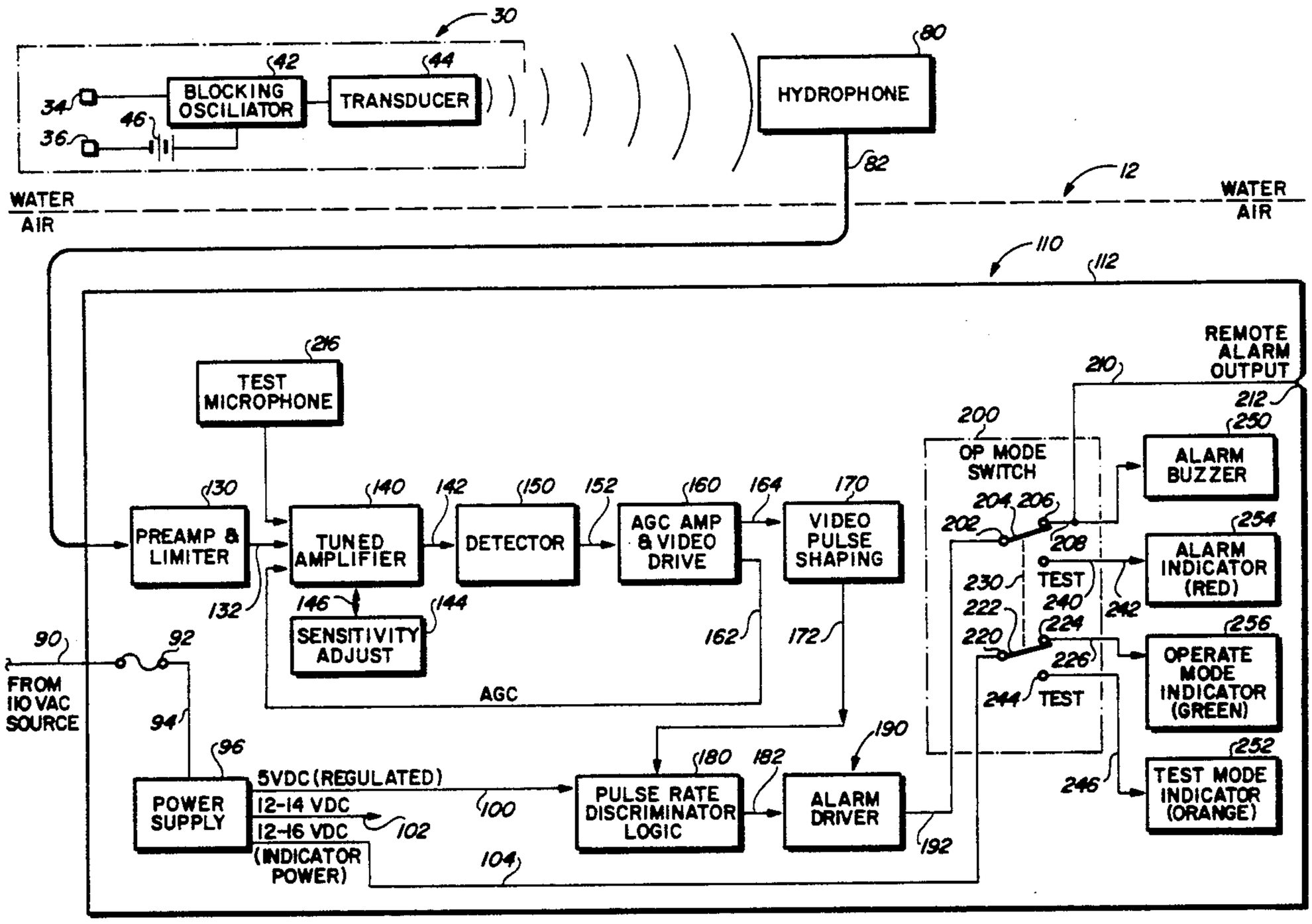
[57] **ABSTRACT**

Pulsed ultrasonic apparatus for monitoring a swimming pool includes a transmitter housing securable to a child and provides a swept frequency pulsed output from a transducer within the housing when an electrical circuit is completed by having a pair of tabs on the outside of the housing immersed in water. The output from the transducer is detected by a receiving hydrophone and the hydrophone is connected to receiver circuitry which provides an appropriate alarm signal.

7 Claims, 2 Drawing Sheets



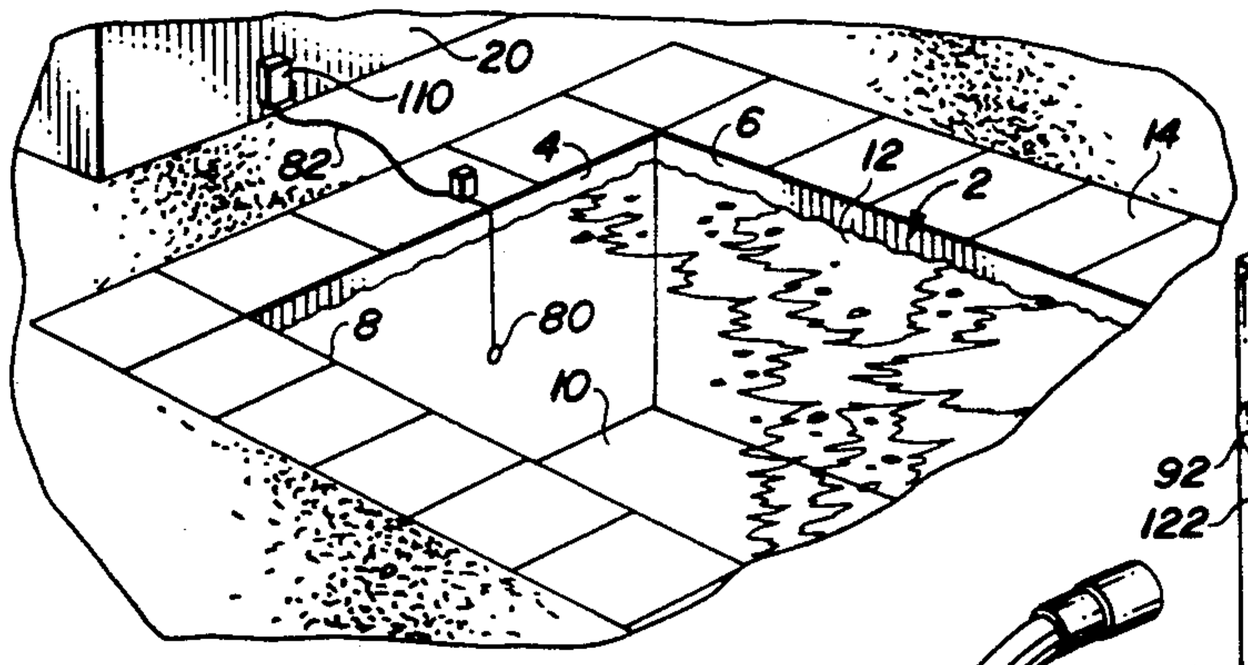


FIG. 1

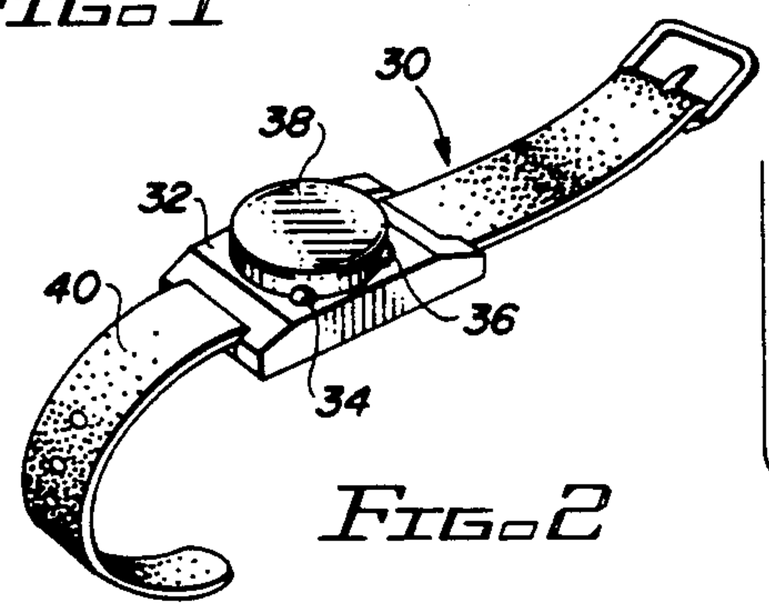


FIG. 2

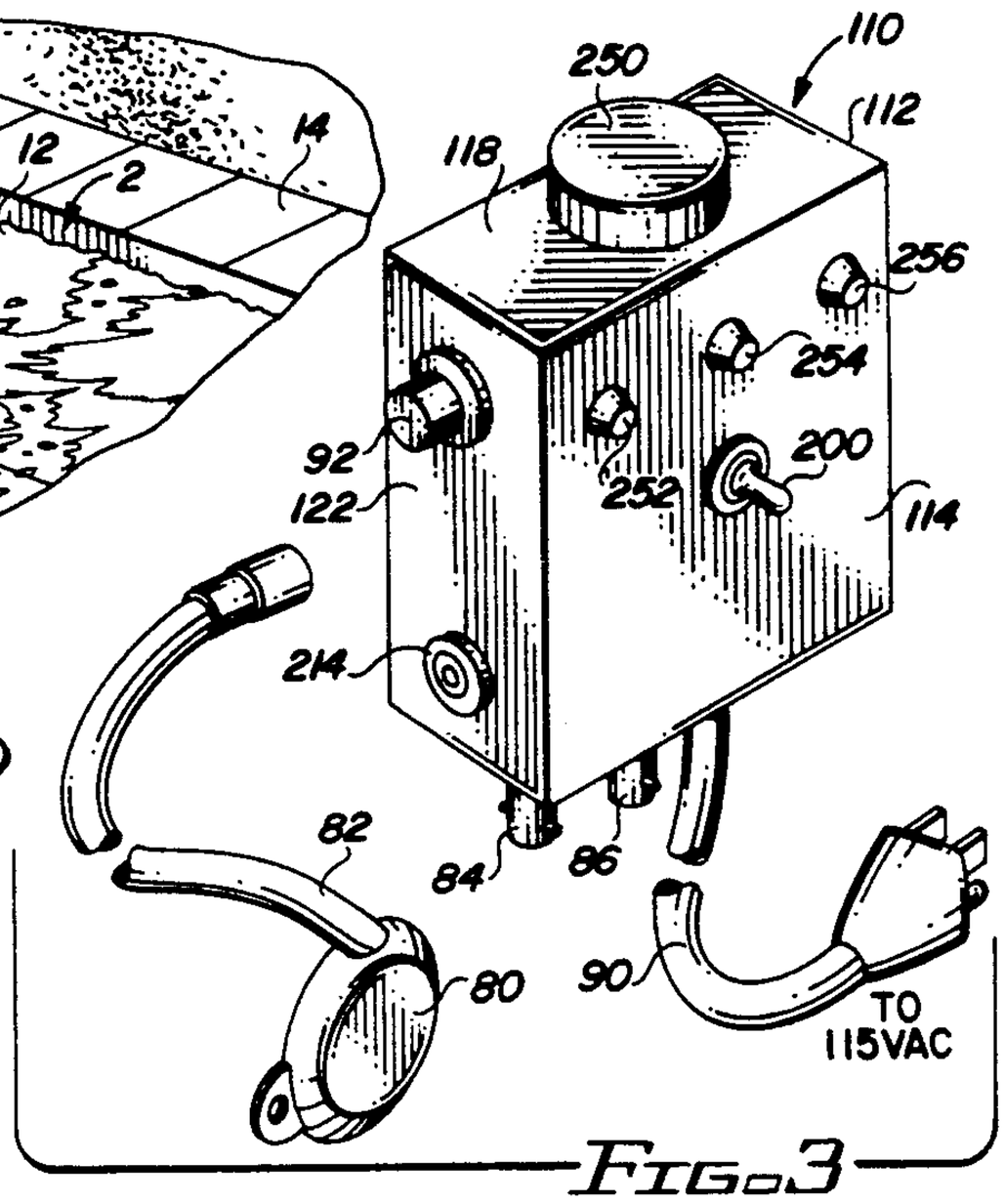


FIG. 3

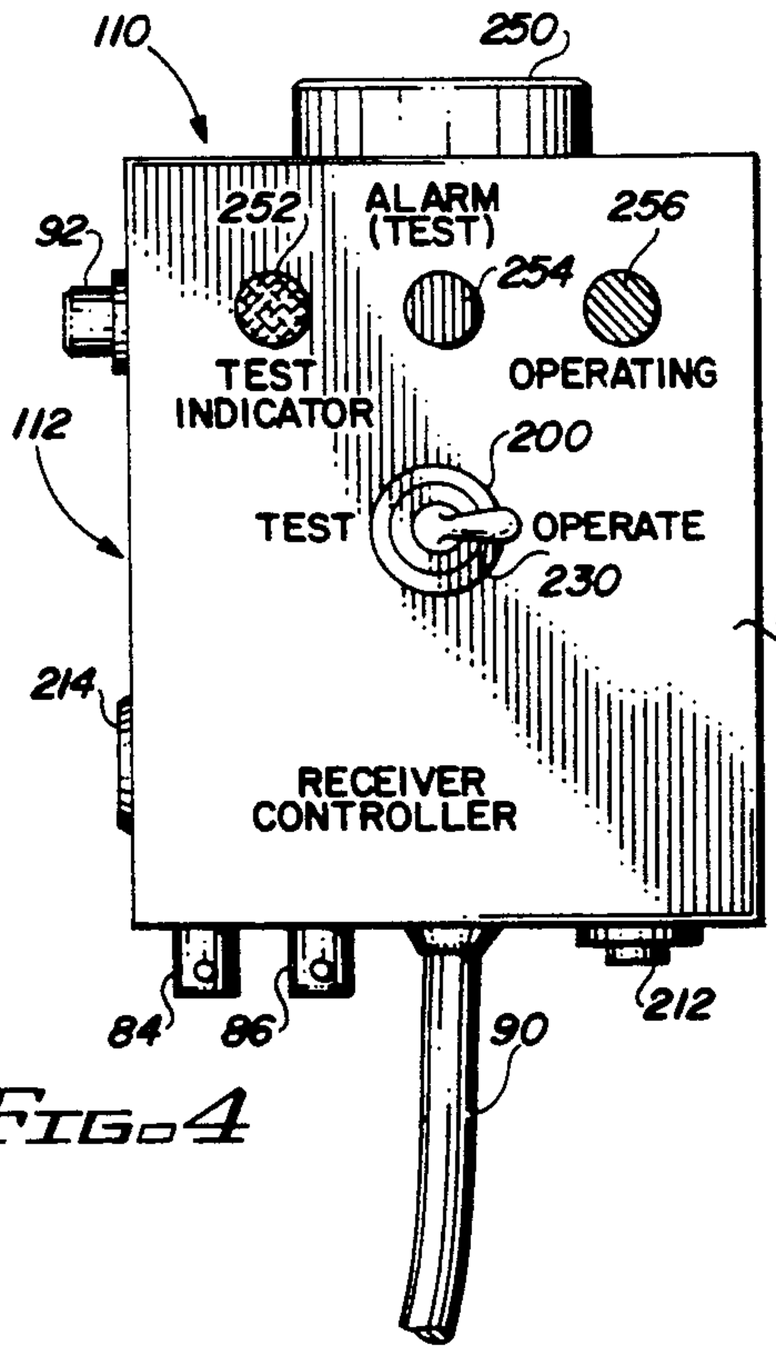


FIG. 4

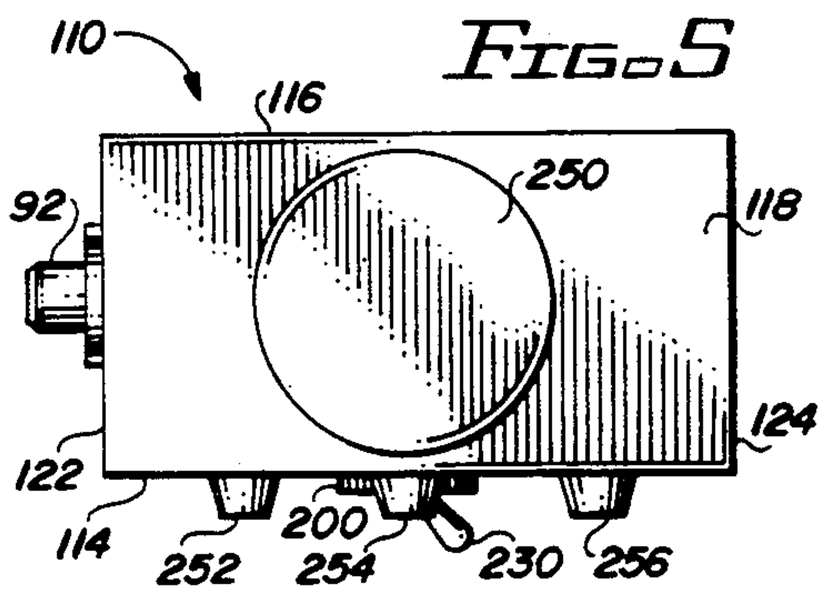


FIG. 5

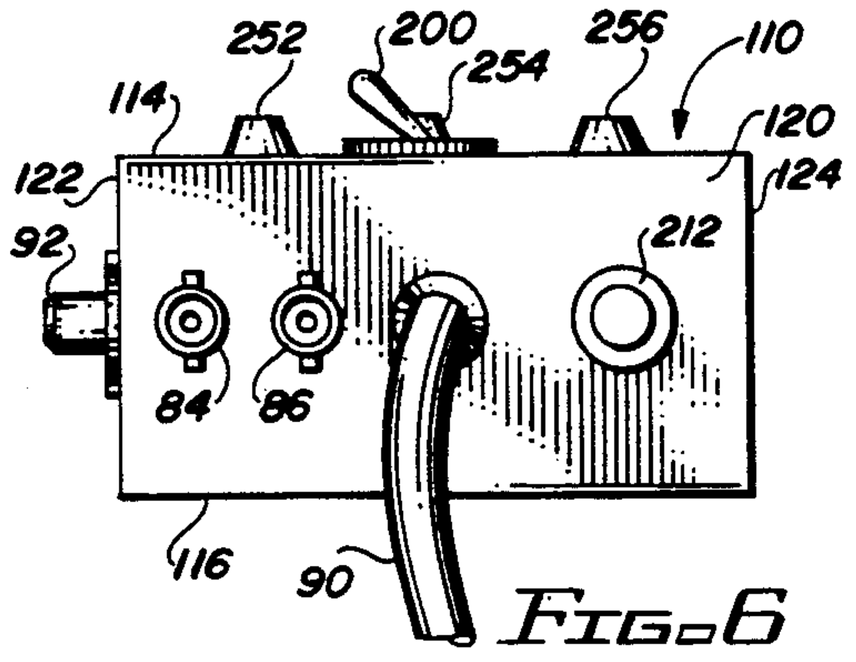
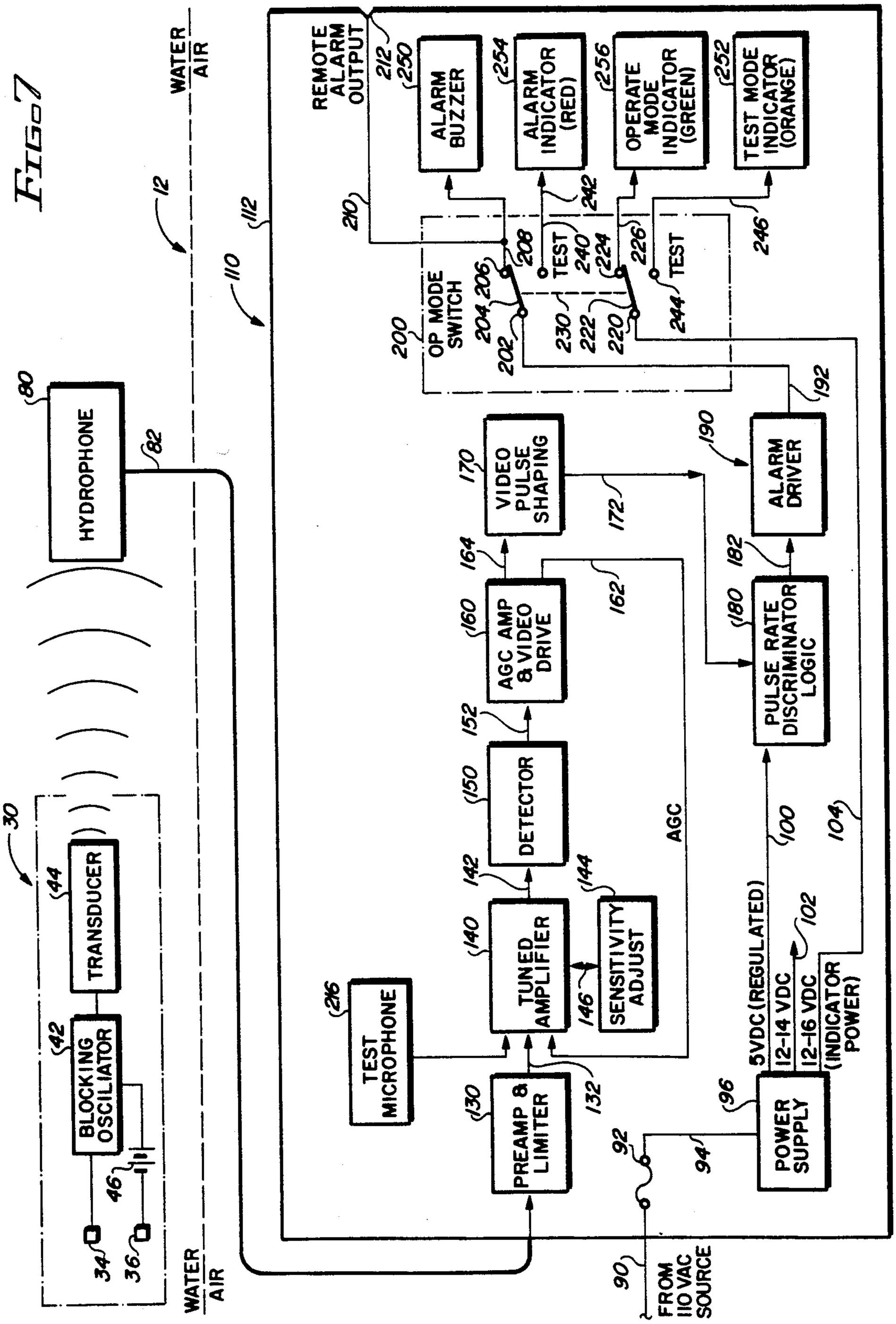


FIG. 6

Fig. 7


WATER
AIR
12
112
110
80
HYDROPHONE
82
30
42
BLOCKING OSCILIATOR
44
TRANSDUCER
46
34
36
WATER
AIR
REMOTE ALARM OUTPUT
212
250
ALARM BUZZER
254
ALARM INDICATOR (RED)
256
OPERATE MODE INDICATOR (GREEN)
252
TEST MODE INDICATOR (ORANGE)
210
200
OP MODE SWITCH
204
206
202
208
TEST
240
242
224
226
TEST
230
222
220
244
246
170
VIDEO PULSE SHAPING
172
190
ALARM DRIVER
192
164
160
AGC AMP & VIDEO DRIVE
162
182
180
PULSE RATE DISCRIMINATOR LOGIC
152
150
DETECTOR
142
140
TUNED AMPLIFIER
144
146
SENSITIVITY ADJUST
AGC
216
TEST MICROPHONE
130
PREAMP & LIMITER
132
92
94
96
5VDC (REGULATED)
12-14 VDC
12-16 VDC
(INDICATOR POWER)
100
102
104
POWER SUPPLY
90
FROM 110 VAC SOURCE

PULSED ULTRA SONIC SWIMMING POOL ALARM APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates swimming pool alarms and, more particularly, a swimming pool alarm system using several elements, including an ultrasonic transmitter secured to a child, a hydrophone disposed in the swimming pool and connected to appropriate receiver circuitry for providing an audible alarm in response to the operating transmitter being immersed in the pool.

2. Description of the Prior Art

There are different types of swimming pool alarms in contemporary use. One type of swimming pool alarm includes some type of electronic monitoring or sensing of an area about a swimming pool. When a child intrudes into the guarded area, some type of alarm sounds. Such systems are generally quite expensive to both install and to maintain.

Another type of swimming pool alarm system in the prior art includes a covering over a swimming pool and a sensor connected to the cover. When the cover is disturbed, as by a child falling onto it, etc., and audible alarm sounds.

Still another type of alarm apparatus used for a swimming pool is an alarm on a gate. When the gate is opened, a buzzer, or the like, sounds to alert people of the fact that the alarmed gate has been opened.

Another type of swimming pool alarm system utilized wave action to sound an alarm. Wave motion resulting from a body, large or small, falling into the pool is sensed and an alarm sounds.

All of the various types of alarm systems have a single purpose, and that is to alert adults that a child has fallen, or may fall, into a swimming pool. The apparatus of the present invention utilizes current technology to provide a transmitter securable to a child's body or clothing and that is activated when it is immersed in water. The transmission is received and an audible alarm sounds.

SUMMARY OF THE INVENTION

The invention described and claimed herein comprises a miniature, pulsed ultrasonic transducer/transmitter securable to a child. The transmitter is activated when it is immersed in water. When the transmitter is activated, its output is a continuous stream of ultransonic pulses that sweep over a predetermined frequency range and are detected or received by a hydrophone disposed in the swimming pool. The hydrophone is in turn connected to an exterior sound generating apparatus that provides an audible alarm when the ultrasonic transducer, the transmitter on the child, is activated by the water.

Among the objects of the present invention are the following:

To provide new and useful pool alarm systems;

To provide new and useful swimming pool alarm system including a pulsed, ultrasonic transmitter and a hydrophone receiver;

To provide a new and useful ultrasonic transmitter that is activated when immered in water;

To provide a sweep frequency transducer for an ultransonic transmitter;

To provide new and useful alarm system for a swimming pool including a hydrophone disposed in the swimming pool and a transmitter securable to a child.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a perspective view of the use environment of the apparatus of the present invention.

FIG. **2** is a perspective view of transmitter apparatus which is a portion of the apparatus of the present invention.

FIG. **3** is a perspective view of part of the receiver apparatus which is also a portion of the apparatus of the present invention.

FIG. **4** is a front view of a portion of the apparatus of FIG. **3**.

FIG. **5** is a top view of the apparatus of FIG. **4**.

FIG. **6** is a bottom view of the apparatus of FIG. **4**.

FIG. **7** is a block diagram illustrating the operation of the apparatus of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. **1** is a perspective view showing a swimming pool **2** which is the use environment of the apparatus of the present invention. The swimming pool **2** includes, as shown in FIG. **1**, an end wall **4** and a pair of side walls **6** and **8**. There is also shown a swimming pool bottom **10**. The pool **2** is filled with water **12**. There is a deck or periphery **14** about the pool. A building **20**, which may be a house, is spaced apart form the pool **2**. On the wall of the building **20** is a receiver **110**. The receiver **110** is connected to a hydrophone **80** by a cable or appropriate electrical conductor **82**.

The hydrophone **80** is disposed in the pool **2** and in the water **12** on the wall **4**. The hydrophone **80** is connected to the receiver **110** by the cable **82**.

FIG. **2** is a perspective view of a transmitter **30**, which is in the form of a wrist element, or an element to be secured to a user's wrist. A typical user would be a child who would be in danger if the child fell into the water **12** or the pool **2**.

The transmitter **30** includes a base housing **32** secured to a strap **40**. The strap **40** would be secured to the users wrist. The transmitter **30**, by means of the strap **40**, could also be secured to a users ankle, if desired. In some small children, it may be advantageous to have the transmitter **30** secured about an ankle, rather than a wrist.

Secured to the base housing **32** is a conductive tab **34** and a conductive tab **36**. The conductive tabs **34** and **36** are spaced apart from each other. They are in turn secured to elements within a transducer housing **38**.

When the tabs **34** and **36** are immersed in water, a circuit is completed to elements within the transducer housing **38**, and appropriate ultransonic signals are transmitted through the water. The transmitter **30** provides ultrasonic vibration in bursts of pulses. The pulses are received and decoded as discussed below, and an appropriate alarm signal is generated.

With respect to the apparatus of the present invention, if a child were to fall into the water **12** of the pool **2**, with the transmitter **30** secured to the child, the water **12** would act as a conductor between the tabs **34** and **36** and a transducer within the housing **38** would be activated and would transmit pulses which would be received by the hydrophone **80** and relayed by the cable **82** to the receiver **110**. In turn, circuitry as illustrated in FIG. **7** would ultimately provide an alarm to alert peo-

ple that a child wearing the transmitter **30** has fallen into the water **12** of the pool **2**.

FIG. **3** is a perspective of the receiver **110**, and particularly of the housing **112** of the receiver **110** and its associated components. FIG. **4** is a front view of the housing **112** of the receiver **110** illustrating various elements or components. FIG. **5** is a top view of the receiver **110** and its housing **112**, and FIG. **6** is a bottom view of the housing **112** of the receiver **110**. FIG. **7** is a view illustrating the circuitry involved in the receiver **110** and a schematic representation of the transmitter **30** and the operation of the transmitter **30** and the hydrophone **80** and the receiver **110**. For the following discussion, reference will primarily be made to FIGS. **3**, **4**, **5**, **6**, and **7**.

The receiver **110** includes a housing **112** which is preferably a generally rectangular box. The housing **112** includes a front panel **114**, a back panel **116**, a top panel **118**, a bottom panel **120**, and a pair of side panels **122** and **124**.

Within the housing **112** is the circuitry which receives pulse from the transmitter **30** through the hydrophone **80**. The hydrophone **80** is connected to the receiver **110** through the cable **82**. The cable **82** is connected to an appropriate connector **84** on the bottom panel **120** of the housing **112**.

Power for the circuitry in the receiver **110** is provided by connection to 110 volt house current by an input power cable and plug **90**. Input power is routed through a fuse **92** and a conductor **94** to a power supply **96**. The power supply **96** provides three different voltages, including a five volt DC regulated voltage on a conductor **100**, a 12 to 14 volt DC power supply on a conductor **102**, and a 12 to 16 volt DC power on a conductor **104**. This will be discussed in more detail below.

The transmitter **30**, when the tabs **34** and **36** are immersed in water, produces a continuous stream of periodic bursts of electrical signals at ultrasonic frequencies. The ultrasonic electrical energy from a blocking oscillator **42** excites a piezoelectric transducer **44** which transmits the resulting acoustic vibrations into the pool water **12**.

The pulses or bursts of ultransonic energy are separated in time in order to provide sufficient time for the echoes to diminish to a noninterference level in the water **12** prior to the reception of the next pulse burst.

The transmitter **30** includes the blocking oscillator **42** connected to the transducer **44**. The blocking oscillator **42** provides a frequency range for the transducer **44** to insure that a predetermined frequency range is swept. The pulses from the transducer **44** accordingly are dispersed to provide a signal that will be received by the hydrophone receiver **80** regardless of where the transmitter **301** child is located in the pool **2**. The walls **4** . . . **8**, the bottom **10**, etc., of the pool and the orientation of the child as it falls into the pool **2** will not block the output pulses from the transmitter **30** due to the swept frequency of the output pulses. That is, the use of a swept frequency output signal prevents dead spots or nulls or zones of silence, due to the configuration of the swimming pool or the orientation of a child as the child falls into the water, from blocking the output signal from being received by the receiver **80**. This insures that some part of the output signal will be received even though other parts may be blocked. The sweeping of the frequencies causes the zones of silence to move back and forth to prevent fixed dead spots in the pool.

The oscillator **42** is connected to the tab **34**. A battery **46** is secured to the tab **36** and to the oscillator **42** to provide power for the transmitter **30**. When the tabs **34** and **36** are immersed in water, the circuit between the battery **4** and the oscillator **42** is complete, and swept frequency pulses from the transducer are transmitted in the water **12** of the pool **2**.

The receiving hydrophone **80**, which may be permanently installed on the wall **4** of the pool **2**, includes a piezoelectric transducer that produces an electrical signal responsive to the acoustic vibrations in the pool. The electrical response from the hydrophone **80** is transmitted through the cable **82**, which may be a coaxial cable, to a preamplifier and limiter **130** within the housing **112** of the receiver **110**. In the circuitry involved in the receiver **110**, the signals are appropriately processed, detected, and the pulses received by the hydrophone **80** are appropriately evaluated. If the received pulses are identified as signals from the transmitter **30**, an appropriate alarm is sounded.

The preamplifier and limiter **130** provides an appropriate gain for the signal received from the hydrophone **80**. The pre-amplifier and limiter **130** passes on signals to a tuned amplifier **140** on a conductor **132**. Sensitivity of the tuned amplifier **140** is varied by an adjuster **144**. The sensitivity adjust **144** is connected to the amplifier **140** through coupling **146**. The purpose of the sensitivity adjustment is to accommodate the sensitivity requirements of individual pools.

Power for the preamplifier and limiter is on conductor **102** from the power supply **96**.

From the tuned amplifier **140**, an output signal is transmitted on a conductor **142** to a detector **150**. Within the detector **150**, appropriate filtering of the signal takes place to prevent noise spikes from producing an unwanted response and to reduce the amplitude modulation of the incoming signal.

From the detector **150**, an output signal on a conductor **152** is transmitted to an automatic gain control amplifier and video drive circuitry **160**. The circuitry **160** serves as a threshold detector and amplifier for that portion of the detected signal from the hydrophone **80** which exceeds a certain predetermined minimum required to turn on the electrical elements, or an electrical element, such as an appropriate transistor, in the circuitry **160**.

Automatic gain control of the detected amplifier signals is accomplished by providing a closed loop in which the output from the circuitry **160** is transmitted on a conductor **162** back to the tuned amplifier **140**. An output signal from the circuitry **160** is also transmitted on a conductor **164** to a video pulse shaping circuitry **170**. The video pulse shaping circuitry **170** further shapes and conditions the output pulses to provide a desired signal output. The output signal from the video pulse shaping circuitry **170** is transmitted on a conductor **172** to a pulse rate discriminator logic **180**.

The pulse rate discriminator logic **180** receives regulated five volt DC power on the conductor **100** from the power supply **96**. Its input signal is on the conductor **172** from the video pulse shaping circuit **170**.

The pulse rate discriminator logic circuitry **180** includes logic circuitry to determine whether the stream of pulses from the video pulse shaping circuit **170** meet predetermined criteria. The predetermined criteria are that the incoming pulses are in fact the result of the ultrasonic pulses from the transmitter **30**, indicating that the transmitter **30** has been immersed in water and is

transmitting a signal, and that output signal is the signal received by the hydrophone **80**.

The pulse rate discriminator logic **180** includes a monostable multivibrator, or a one shot (OS) multivibrator, having a minimum "on" period of preestablished or predetermined time in accordance with the circuitry criteria. At the beginning of an interrogation cycle in the pulse rate discriminator logic circuitry **180**, the first arriving pulse actuates the one shot (OS) multivibrator, and the "on" time of the multivibrator defines the period or cycle time of the pulse rate query. At the beginning of the query cycle, the input pulses are directed to a decade counter, the output of the counter moves to the "on" state at the end of ninth received pulse and the counter remains in that "on" state for one pulse period and then return to the "off" state.

The falling edge of the counter output sets a flip-flop (FF), the output of which moves to the "on" state and remains in that state until reset. At the end of the query period the query OS is combined with the state of the previously mentioned FF output. If the FF is in the "on" state, indicating that at least ten pulses have been counted during the query period, a pulse is sent to an alarm indicating "retriggerable monostable multivibrator" or ROS at the end of the query period when the query one shot multivibrator output returns to the "off" state. The pulse sent to the "fail" ROS sets the ROS to the "on" state to indicate the detections of the presence of a transmitter. This "fail" ROS remains in the "on" state for a predetermined time period if no further fail indication pulses arrive within that time period.

At the end of the query period a pulse is sent to a reset ROS. This ROS generates a short pulse at this time to reset the FF to the "off" state and the counter to zero. At this time the input pulses are redirected from the counter input to the query OS to repeat the cycle. This period of the query OS is sufficient time for eleven pulses to arrive at the counter. This allows one pulse of eleven to be missed in the alarm decision.

The delay period of the retriggerable "fail" ROS can be any value greater than the query period. Each query cycle that indicates a detected alarm situation extends the period of distress by the normal 0.6 second delay of the alarm (fail) ROS. This results in a continuous alarm command as long as ten or more pulses are detected.

The normal delay period of this ROS could be extended to provide a delay of twice that of the query period. For this condition a single query period in which a count of ten is not reached would not turn off the alarm. Extensive testing indicates that this is not necessary. The fact that the alarm turns off for a fraction of a second does not detract from the alarm significance.

In summation, the alarm criteria for the pulse rate discriminator **180** is only that the pulse rate is ten or more pulses within a predetermined time period.

The output of the pulse rate descriminator **180** drives a transistor, the collector of which supplies a circuit ground as a drive mechanism for an alarm buzzer **250** or other indicator. Resistor and diodes can isolate the primary alarm buzzer **150** and remote alarms to prevent a failure in one alarm from affecting the operation of the others.

The signal evaluation process requires approximately 0.35 seconds to complete. When a match is found, the alarm will sound until the transmitter is removed from the pool. The nature of the alarm for the engineering prototype is a repeating series of 'beeps' having an on-off cycle of approximately 1.5 seconds. When the transmitter is removed approximately 80 feet, an additional receiving transducer or hydrophone may be introduced to provide better coverage of the pool volume. That additional hydrophone may be connected to a connector jack **86** on the bottom panel **120**. The jack **86**, is, of course, appropriately connected to the preamplifier and limiter **130** in parallel with the input from the hydrophone **80**.

When the received pulses have been determined by the pulse rate discriminator logic **180** to be the appropriate pulses received from the hydrophone **80** from the transmitter **30**, an alarm driver **190** receives an appropriate output signal from the pulse rate discriminator logic **180** on conductor **182**.

From the alarm driver **190**, an appropriate signal is sent on a conductor **192** to the alarm buzzer or audible alarm **250** through a switch **200**. The switch **200** includes a pair of terminals **202** and **220**, to which are connected armatures or moving elements **204** and **222**, respectively. The armatures **204** and **222** are connected together by a coupling element or test actuator **230**.

The switch **200** is preferably spring biased to connect the contact **202** and the armature **204** to a terminal **206**, and the terminal **220** and armature **222** to a terminal **224**.

Extending from the terminal **206** is a conductor **208**. The conductor **208** extends to the alarm buzzer **250**. A conductor **210** is also illustrated in FIG. **7** extending from the conductor **208** to a remote alarm output jack **212**, on the bottom panel **120** of the housing **112**, and which remote alarm may be within the building **20** or elsewhere, as desired.

The terminal **224** is connected by a conductor **226** to a mode indicator light, such as a green light **256**.

The armature **204** is movable between the terminal **206** and a test terminal **240**. The test terminal **240** is connected to an alarm indicator, which may be a red light **254**, by a conductor **242**. The armature **222** is movable between the terminal **224** and a terminal **244**, which is also a test terminal. The test terminal **244** is connected to a test mode indicator, which may be an orange light **252**, by a conductor **246**.

The terminal **220** is connected to the power supply **96**, and specifically to the 12 to 16 volt DC output from the power supply **96** by the conductor **104**. Accordingly, when the switch **230** is moved to the test position, the armature **222** moves to connect the terminal **220** and the indicator power on conductor **104**, to the orange test light **252** through the terminal **244** and the conductor **246**. The illuminating of the orange test light indicates that power is provided by the power supply **96** at least on the conductor **104**.

when the test switch **230** is moved to the test position, the armature **204** is moved away from the terminal **206** to the terminal **240**. An output from the driver alarm **190** on conductor **192** then is transmitted on conductor **192** and from the terminal **202** and armature **204** to the terminal **240** and the conductor **242** to the alarm indicator red light **254**. However, when the armature **204** moves away from the terminal **206** and moves to the terminal **240**, no output is provided to the alarm buzzer **250** on the conductor **208** or to a remote alarm output **212** on the conductor **210**.

Also for test purposes, a test microphone **216** is shown in FIG. **7** connected directly to the tuned amplifier **140**. The test microphone **216** is connected to the receiver **110** through a jack **214** on the end panel **122** of the housing **112**.

Only one hydrophone **80** is shown in FIG. **1**. However, the number of hydrophones actually used will depend on the size of a particular pool and the shape of the pool. The hydrophone(s) will preferably be installed as a permanent installation. Accordingly, the conductor(s) **82** will not be merely disposed as shown in FIG. **1**. Rather, the electrical wiring will be appropriately concealed, etc., as required and as practical.

For a second hydrophone, a second input jack **86** is shown in FIGS. **3** and **6**. A second input cable, a duplicate of the cable **82**, is not shown.

Not shown in FIG. **7** is a battery backup for the power supply to the preamplifier and limiter **130**. It will be noted that the conductor **102** from the power supply **96** provides 12–14 volts dc for the preamplifier and limiter **130**. For emergency purposes, a 12 volts battery could be used as an emergency backup. Such is well known and understood in the art.

While the apparatus of the present invention has been shown in the environment of a swimming pool, it is obvious that the elements of the invention could also be used to monitor a portion of a lake or other body of water. The number of hydrophones, etc., required would, of course, depend on the size of the body of water being monitored.

While the principles of the invention have been made clear in illustrative embodiments, there will be immediately obvious to those skilled in the art many modifications of structure, arrangement, proportions, the elements materials, and components used in the practice of the inventions, and otherwise, which are particularly adapted to specific environments and operative requirements without departing from those principles. The appended claims are intended to cover and embrace any and all such modifications, within the limits only of the true spirit and scope of the invention.

What I claim is:

1. Pulsed ultrasonic alarm apparatus for providing an alarm when a child has fallen into a body of water, such as a swimming pool, comprising, in combination:

means for providing a swept frequency output signal in the body of water in response to the child's falling into the body of water the sweeping of said frequency preventing fixed dead spots in the body of water;

receiver means in the body of water for detecting at least some part of the swept frequency output signal; and

means for providing an alarm signal in response to the detected output signal.

2. The apparatus of claim **1** in which the means for providing the swept frequency output signal includes transducer means for providing output pulses at ultrasonic frequencies.

3. The apparatus of claim **2** in which the receiver means includes a hydrophone.

4. The apparatus of claim **1** in which the means for providing a swept frequency output signal includes housing means for electrical circuitry securable to a child.

5. The apparatus of claim **4** is which the means for providing a swept frequency output signal further includes a pair of tabs secured to the housing means and electrical circuitry disposed in the housing means, the tabs being connected to the electrical circuity in the housing means.

6. The apparatus of claim **5** in which the electrical circuitry includes a blocking oscillator for providing a plurality of frequencies and a transducer connected to the blocking oscillator for providing bursts of ultrasonic pulses in response to the blocking oscillator.

7. The apparatus of claim **6** in which the tabs comprise terminals which complete an electrical circuit to the blocking oscillator when immersed in water.

* * * * *